Automatic Dependent Surveillance – Broadcast (ADS-B "Outputs") Overview

Pete Skaves & Rob Duffer, AIR-130
Avionics Branch, January 25, 2006

Briefing Objectives

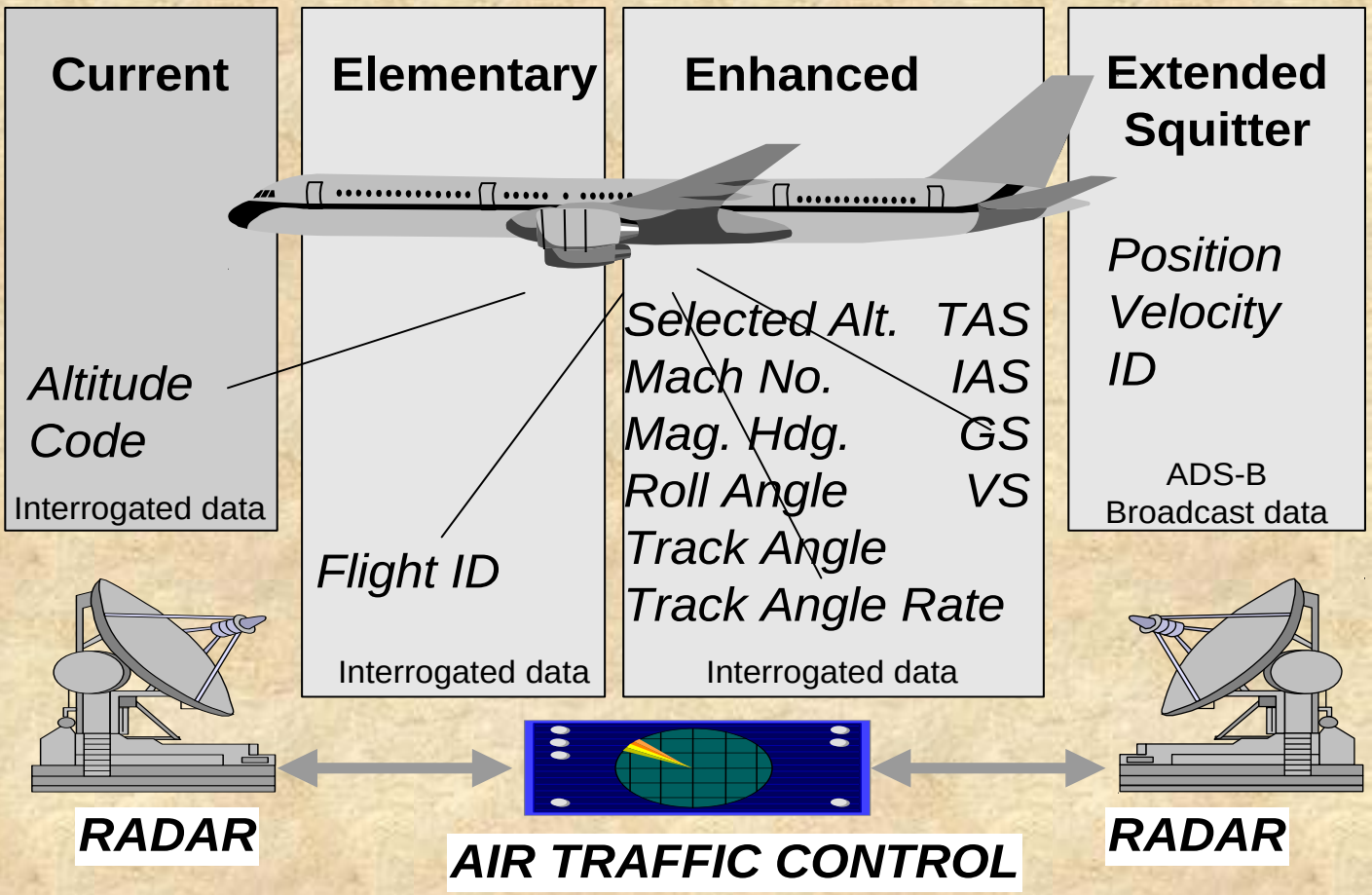
ADS-B "Outputs" presentation overview:

- ✓ ***Aircraft Surveillance Mandates Current & Proposed***
- ✓ ***RTCA Minimum Operational Performance Standards (MOPS) for Transponders***
- ✓ ***Technical Standard Orders (TSO) for Transponders***
- ✓ ***Required aircraft avionics wiring connections to transponders for ADS-B "outputs"***
- ✓ ***ADS-B "outputs" air-to-air considerations***
- ✓ ***ADS-B "outputs" air-to-ground considerations***
- ✓ ***ADS-B "outputs" Navigation Vs. Surveillance avionics dependency issues***
- ✓ ***ADS-B "outputs" System Safety Assessment Pro***
- ✓ ***ADS-B "outputs" own-ship position source(s)***
- ✓ ***Discussion and wrap-up***

Recent Surveillance Mandates

- Elementary Surveillance (ELS): 2003
  - ✓ European Mandate
  - ✓ Air-to-Ground application
- Enhanced Surveillance (EHS): 2005
  - ✓ European Mandate
  - ✓ Air-to-Ground application
- FAA Advisory Circular 120-86 “Aircraft Surveillance systems and Applications” has invoked JAA guidance material in support of the European mandates

Current Aircraft Surveillance Reporting Configurations



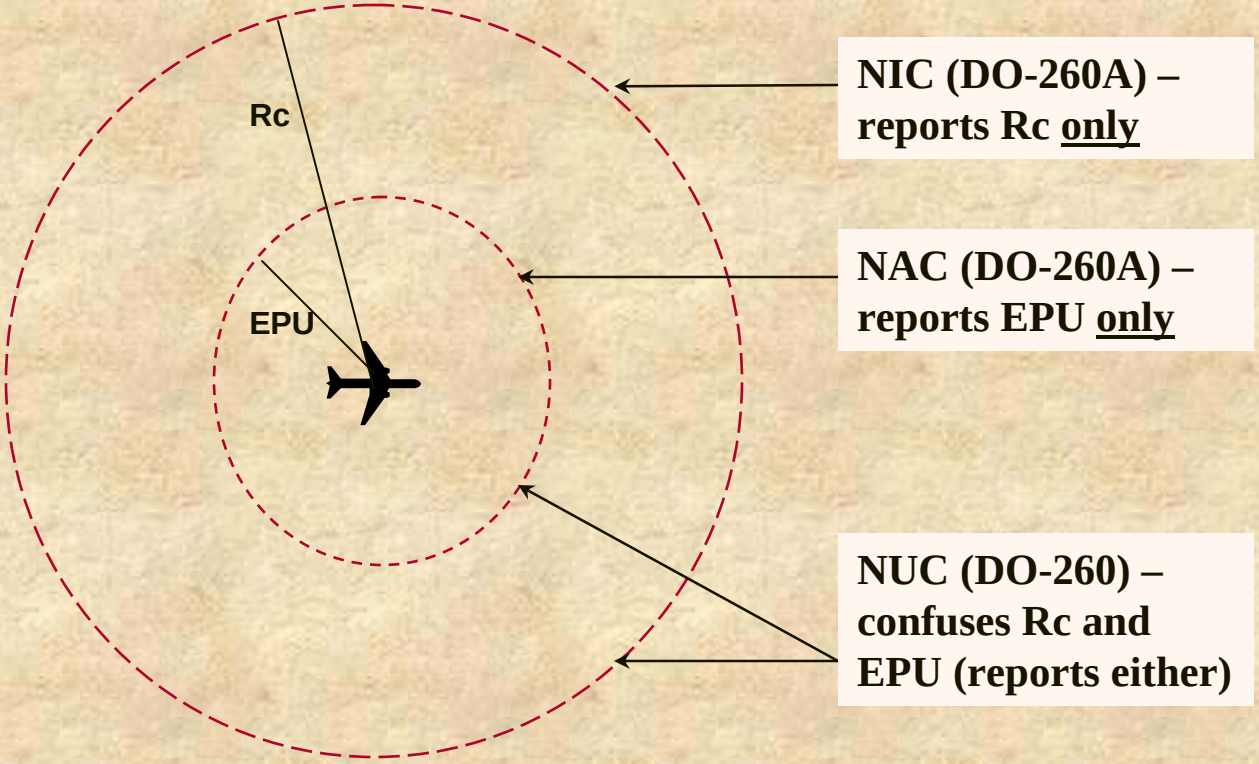
Aircraft ADS-B "Outputs" Road Map

- **Publish TSO C166A to invoke RTCA DO-260A to correct the following discrepancies:**
  - ✓ **Correct reporting of position integrity & accuracy**
    - **Current XPDRs can report high integrity for GPS position even though onboard GPS is reporting low integrity Mode A Code broadcast capability**
    - **A significant portion of US domestic fleet does not have Flight ID capability and need Mode A broadcast Version number in ADS-B broadcast**
    - **Ground station will now be able to identify aircraft broadcast capability**

RTCA MOPS Transponder Issues

- RTCA DO-260 Vs. DO-260A "MOPS for 1090MHz Extended Squitter ADS-B and Traffic Information Services – Broadcast (TIS-B)
  - ✓ RTCA DO-260 has been superseded
  - ✓ Navigation Uncertainty Category (NUC) should be replaced by Navigation Integrity Category (NIC), Navigation Accuracy Category (NAC) and System Integrity Level (SIL)
- Transitioning from RTCA DO-260 to RTCA DO-260A will require avionics upgrades
- Upgrades will be required when ADS-B mandates are in effect

260 vs. 260A transponder: *Simplified Differences Diagram*



1. **EPU** – (Estimated Position Uncertainty) – radius of a circle, centered on the reported position, such that the probability of the actual position being outside the circle is 0.05. **NAC** reports EPU bound.
2. **Rc** - (Integrity Containment Radius) – radius of a circle, centered on reported position, within which the true position is assured to lie (The probability of of exceeding Rc without alerting is reported by the **SIL** (Surveillance Integrity Limit Parameter)).

ADS-B “Outputs” and Global Harmonization

Transponder Capability and Compliance

ELS / EHS & Basic Compliance			ES (ADS-B-Out) Compliance	
	ELS/EHS & Basic XPDR DO-181C/ ED-73A	ES (ADS-B-Out) Capable	ADS-B DO-260 (*old*)	ADS-B DO-260A (*current*)
ACSS (XS-950) 7517800-11006	Yes	Yes	No	No
Collins(TPR-901) 822-1338-003	Yes	Yes	No	No
Honeywell(TRA-67A) 066-01127-1602	Yes	Yes	No	No

Note: Currently, transponders are not required to comply to ADS-B standards

Standardization of Aircraft ADS-B Outputs Definition(s)

- **The definition of ADS-B "outputs" has not been standardized**
- **The following surveillance functions are often confused as the standard for ADS-B "outputs"**
  - ✓ **European ELS/EHS surveillance program**
  - ✓ **The Capstone ADS-B program**
  - ✓ **Australian ADS-B program**
  - ✓ **Traffic Information Surveillance – Broadcast (TIS-B)**
- **Summary**
  - ✓ **ADS-B "outputs" industry standards (e.g., TSO-C166A) have not yet been invoked by the FAA**
  - ✓ **Recommend that TSO-C166A be issued to invoke RTCA DO-260A**
  - ✓ **Update Surveillance AC 120-86 to incorporate this new standard**

Harmonization of Aircraft ADS-B Outputs Definition(s) with ATO

- **Harmonization of Aircraft ADS-B "outputs" with the Air Traffic Control Organization (ATO) is required for air-to-ground operations**
- **ADS-B "output" message set parameters for safety, performance and interoperability should be harmonized with both domestic and international regulatory authorities**

Aircraft Wiring Connectivity for ADS-B Outputs

- **The transponder installation and certification costs for ADS-B "outputs" will be greatly impacted by the aircraft avionics configuration**
  - ✓ **Classic airplanes without GPS and FMS**
  - ✓ **Glass cockpit airplanes with FMS & GPS**
  - ✓ **Glass cockpit airplanes with FMS only**
  - ✓ **General Aviation Airplanes**
  - ✓ **Business Jets**

- **In summary, re-wiring the airplanes to provide analog and digital signals for ADS-B outputs may exceed the basic cost of the transponder installation**
- **Due to the various combinations of aircraft wiring many different types of STC/Service Bulletins may be required**

ADS-B "Outputs" Navigation Vs. Surveillance Avionics Dependency Issues

- **Dependencies currently exist for current transponder altitude reporting**
  - ✓ **Aircraft transmit altitude to controllers with mitigation**
  - ✓ **Controllers compare altitude reporting from the flight crew with the transponder altitude outputs each time the aircraft enter controlled airspace**
- **Will additional mitigations be required for ADS-B outputs ?**
- **Aircraft surveillance and navigations functions have typically been classified as "major" due in part to independence between the two functions**
  - ✓ **It may not be economically feasible to develop an ADS-B "outputs" avionics system in support of a "Hazardous" or "Catastrophic" Failure condition**

ADS-B "Outputs" Own-Ship Position Source(s) (sheet 1 of 2)

- **Two long range independent navigation sources are currently required for National air Space Operations**
  - ✓ **Navigation performance is based in part on flight phase (en route, terminal area, takeoff, approach, oceanic remote)**
- **Current Transport Category Airplanes have various navigation sensor sources:**
  - ✓ **ILS-LOC**
  - ✓ **GPS**
  - ✓ **DME-DME**
  - ✓ **VOR-DME**
  - ✓ **INS**
- **The airspace requirements for ADS-B "outputs will determine the best navigation sensor backup strategy**

ADS-B "Outputs" Own-Ship Position Source(s) (sheet 2 of 2)

- **General Aviation Aircraft**
  - ✓ **Rulemaking is currently in progress to allow the use of GPS WAAS without backup**
  - ✓ **If available, this would be ideal for ADS-B "outputs"**
- **Possible GPS / backup combinations**
  - ✓ **DME-DME**
  - ✓ **VOR-DME**
  - ✓ **INS**
  - ✓ **LORAN**
- **The airspace requirements for ADS-B "outputs will determine the best navigation sensor backup strategy**

Questions & Wrap-Up